Patent Application of
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for
A Staff Sheet Printer

Background – Cross Reference to Related Applications

This application claims the benefit of Patent Application Serial # 09/866,220 filed 2001, May 25.

Background - Field of Invention

This invention relates to a music printer that increases performance of a musical instrument player.

Background – Description of Prior Art

A musical instrument player often starts taking music lessons as young as two or three years old. Giving musical lesson to children are always fun and exciting events for both children and their parents. However, these lessons require always very diligent, patient, hard working, and enormous support from their parents and teachers.
Hence, over many years there are many devices were invented to give support for them. However, there is no advanced devices are invented for some traditional instruments such as Japanese Koto or xylophone musical instruments. Continuing and keeping playing traditional skill from generation to next generations is not easy because there is luck of

teachers and luck of teaching aid devices such as this newly invented printer. Using this newly invented staff sheet printers, teachers can teach these traditional musical instruments to music players easily.

Objective and Advantage

Accordingly, besides the objects and advantages of the staff sheet printer described in this patent, several objects and advantages of the present invention are:

(a) to provide the staff sheet printer that can print played notes which can be compared with original music sheets to see if there are errors made or not as musical instrument players practices musical instruments;

(b) to provide the staff sheet printer that can improve performance of the musical instrument players by fine tuning playing skills by measuring notes precisely since this newly invented staff sheet printer can print played notes exactly as it is played by the player;

(c) to provide the staff sheet printer that the musical instrument players can save lesson fee and time using this staff sheet printer since repetitive lesson fees are not required; and

(d) to provide the staff sheet printer that the musical instrument player can make hardcopy duplicates of own music notes easily.

Summary

A conventional way to practice music instruments is to simply play, and record the playing music by conventional recording devices such as tape players and playing the recorded music back. Then a musical instrument player can find out where mistakes occur while

they listen to the tape player. Alternatively, a music teacher can listen while the musical instrument player plays. Finding and correcting any errors made by the musical instrument player depends on the capability of human ears. However, the human ears have limited hearing capability to be able to listen with high degree of accuracy. Hence, the music teachers or the musical instrument players can not catch all errors by checking the recorded sound or while the music teachers or the musical instrument players listen. This task requires highly trained and skilled music teacher when a novice musical player plays. Often correcting any errors made by them are far more difficult than finding errors made by beginners. By using this newly invented staff sheet printer, any instrument players can find out mistakes by comparing the printout paper printed and the original music sheets since the played notes are printed exactly as they play. Once all music notes played are stored on this staff sheet printer, by pressing a print button on the staff sheet printer prints played notes onto the paper as the staff sheets. Then, the musical instrument players can compare the difference between the original music sheets and the printed staff sheets visually. Thereby the musical instrument players can improve performance skill in short time because they can see mistakes visually instead of listening to sound.

Brief Description of the Drawing Figures

FIG. 1 shows the newly invented staff sheet printer how it connects to musical instruments using an acoustic Japanese Koto and an acoustic xylophone as the example application.

FIG. 2 shows the functional block diagram of the newly invented staff sheet printer for musical instruments using the acoustic musical instruments.

FIG. 3 shows a plurality of musical fonts used to generate printable bit map for printing staff sheets.

FIG. 4 shows a plurality of musical fonts used in violin as the exceptional fonts.

FIG. 5 shows a font used in flute as the exceptional font.

FIG. 6 shows a staff sheet that has given note with its associated tempo, and its time signature.

FIG. 7 shows a flow-chart how to input the numbered parameters shown in FIG. 6 before the music is played.

Detailed Description of the Preferred Embodiment – FIGS. 1, 2, 3, 4, 5, 6, and 7

FIG. 1 illustrates a typical connection diagram of a newly invented staff sheet printer 100. The staff sheet printer 100 is connected to the acoustic xylophone 10 and Japanese Koto 20 as the typical example application. In reality, the staff sheet printer 100 can connect to any musical instruments by changing the physical shapes and characteristics of the sensors 130-1 and 130-2 (FIG. 2).

Referring to FIG. 2, the staff sheet printer 100 (FIG. 1) consists of following: sensors 130-1 and 130-2, interface modules for sensors 132-1 and 132-2, signal processing modules 134-1 and 134-2, a multiplexer 135 for the signal processing modules 134-1 and 134-2, memory modules RAM 138, memory modules ROM 116, a CPU module 120, a printer module 136, display module 124, and an operation button interface module 118.

Referring to FIG. 2, the printer module 136 located inside the staff sheet printer 100 (FIG. 1) prints played music notes onto a paper 60 out of the staff sheet printer 100 as the music staff sheets 60. The paper 60 is stored in the staff sheet printer 100 so that the staff sheet printer 100 can print the played music in continues fashion. The printer module 136 has controls functions such as out of paper or out of toner ink, monitoring print engine head, and checking paper jam and other warning messaging system. For example, when out of paper 60 occurs in this newly invented staff sheet printer 100 then the warning

message is sent to the display module 124 via the CPU module 120. Hence, a user can place papers before the user can print. The printer module 136 also controls arrays of pins vertically mounted on a print head, which it translates and prints staff sheets based on the printable bit map data in the memory module RAM 138. The print head is standard print head used in any dot-matrices printers for personal computers. The images are created as the each of arrays of pins strikes ink ribbons and leaving dots on the paper 60 according to the printable bit map data created and stored by the CPU module 120. When higher resolution printing is desired, a laser engine head or a thermal print head can be used to print images using standard laser beam printing technology.

Referring to FIG. 2, the signal-processing module 134 receives signals that are generated by the sensors 130-1 and 132-2. Once the signal-processing modules 134-1 and 134-2 receive the signals through the interface module for musical instrument 132-1 and 132-2, the signal-processing module 134-1 and 134-2 arrange the signals for pre-printing format. Then, the signal-processing modules 134-1 and 134-2 send data to the memory module 138 RAM (random access memory) for later processing. The signal-processing modules 134-1 and 134-2 are analog-to-digital converters. Since all signals sent by the sensors 130-1 and 130-2 are analog signals, they need to be converted into digital signals using analog-to-digital converters. There are many commercially IC chips are readily available to implement this function.

Referring to FIG 2, the staff sheet printer 100 has function buttons to control the functions of this newly invented staff sheet printer 100. These buttons are a S/E start/enter button 102, a STP stop button 104, a R record 106, a P print button 108, a up or down button 109 and 110 respectively, and a cursor left or right position button 112 and 114 respectively. All of these buttons are interfaced using the operation button interface modules 118.

Referring to FIG. 2, the display module 124 is mounted on the staff sheet printer 100. The purpose of the display module 124 is to

display responses resulted by the operation of the staff sheet printer 100 when the player pushes the buttons located on the staff sheet printer 100. The display module 124 can display alphanumeric characters and music notes using standard liquid crystal display (LCD) unit 125. The LCD unit 125 has two-rows by twenty-four columns. The CPU module 120 sends the display characters for displaying operational and other messages whenever messages are sent by active modules such as the printer module 136. This display module 136 is also used to display and gather the basic information about the music to be played, such as a given note 121-1 with a tempo 123-1 and its time signature 127-1 of that music depicted in FIG. 6, before the user starts to play. To implement this commercially available LCD unit 125 is simple since they are used in almost all electronic equipment that requires human interface between machines and human.

Referring to FIG. 2, the sensors 130-1 and 130-2 connect to the staff sheet printer 100 externally. The purpose of the sensors 130-1 and 130-2 are to measure how the player plays notes. For each musical instrument's input, such as strings, keys, and pads, has a plurality of the sensors to measure. The sensors 130-1 and 130-2 comprise of piezoelectric or photodiodes or mechanical switches. The sensors can detect vibration, pressure, speed, and distance of each input element of musical instruments. By measuring those parameters, the staff sheet printer 100 can print correct notes on staff sheets according to the tempo 123-1 and time signature 127-1 of that music piece.

For example, to find out the difference between the quarter notes 126-1 and a half note 122-1 used in the music, which has the tempo speed of 100 in FIG. 6, the staff sheet printer 100 needs to know its speed in the given tempo parameter of the music. By measuring characteristic of notes played, the staff sheet printer 100 can figure out whether it is a quarter note or a half note because the length of the quarter note is shorter than the half note. Hence, the staff sheet printer 100 can print correct notes on the staff sheets 60 for a given tempo of the music piece. To figure out the volume sound of each note, the staff sheet printer 100 needs to know how fast each note is pressed. All of these capabilities are possible by having sensors 130-1 and 130-

2 since the sensors keep on monitoring characteristic of musical instruments in real time mode.

Referring to FIG 2, the MUX multiplexer 135 controls the signal processing modules 134-1 and 134-2. Since two musical instruments are connected, the MUX multiplexer 135 instructs each signal-processing unit according to the parameters information about the music provided by the players and the CPU model 120.

Referring to FIG 2, the interface module for sensors A/D 132-1 and 132-2 is used to connect very sensitive sensors 130-1 and 130-2 and the rest of internal modules of the staff sheet printer 100. By the nature of these sensors, the input voltage or current generated by these sensors is very small, and they cannot be interfaced to standard computer circuit directly. Therefore, the staff sheet printer 100 requires the interface modules for sensors, 132-1 and 132-2.

Referring to FIG 2, the memory module 138 RAM is temporarily memory space which is used to store dynamic data sent by the signal processing modules 134-1 and 134-2, while music is played. It is also used to store printable bit map data for printing staff sheets 60.

Referring to FIG 2, the memory module ROM 116, it stores two pieces of software. One is the musical note fonts stored permanently and other is operating software. When the staff sheet printer 100 is turned on, the CPU module reads the operating software from the memory module ROM 116 first. All of instruction used internally by the staff sheet printer 100 is stored in this memory module ROM 116 as the operating software.

Referring to FIG 2, the CPU module 120 is used to control all of modules in the staff sheet printer. Nowadays, the most of CPU (central processing unit) has built-in graphic processor, generating printable bit map data using fonts and signals generated by signal processing module A/D is well within achievable range.

Referring to FIG 3, 4, and 5 all of music notations such as

quarter, half, whole notes, and all music note fonts are stored in the memory module ROM 116 as the bit map font data structure. Fonts, called harmonic notes 401, depicted in FIG. 4, used by violin instruments, not used by piano instrument. A font, called Breath Mark 501, depicted in FIG. 5, used in flute, and are not used by certain types of musical instruments. Since, fonts can vary depending on types of musical instruments played, and they must be stored in the memory module ROM 116.

The CPU module 120 references them to find out correct notes using the dynamic data stored in the memory module RAM 138 and the fonts stored in the memory module ROM 116 when the converted signals are received by the signal-processing modules A/D 134-1 and 134-2. After the CPU module 120 fetches corresponding notes, then it stores in the memory module RAM 138, which is later used to built complete printable bit map data of staff sheets, in real time mode. The CPU module 120 processes all of the signals until the music player press the STP stop button 104.

When the P print button 108 is pressed, then the CPU module 120 builds the printable bit map data, bit by bit, using the fonts stored in the memory module ROM 116 and the corresponding music notes stored in the memory module RAM 138.

The final data is processed and built by the CPU module 120 contains all information including the tempo parameter, the time signature, the staff sheet lines for treble and the bass clefs, and all notes played by the player. They are rendered and stored in the memory module RAM 138 as the printable bit map data format. In other word, the rendered data in the memory module 138 now is the replica of a staff sheet. The memory module RAM 138 can store many pages of data. This data format has 600 dots per inch resolution at the minimum. The default paper size 60 is 8.5 inch by 11 inch for US and A4 paper size in European and Asian countries. The margins, line spacing, and other parameters for printing are pre-programmed since there is no printer drivers used in general printers such as PCL5e or PCL 6 (Printer Control Language designed by Hewlett-Packard Corp.)

Once the printable bit map data for staff sheets is built and stored in the memory module RAM 138 completely, then the CPU

module 120 sends them to the printer module 136. Thereby the printer module 136 prints its image line by line. Each page consists of bit patterns, translated and rendered by the CPU module 120, onto plurality of papers 60 accordingly.

Referring to FIG 7, the flow chart shows the operation of the newly invented staff sheet printer 100. It shows the method to select a musical instrument type, a given note, its tempo, and its time signature.

From the description above, a number of advantages of this newly invented staff sheet printer for practicing acoustic musical instruments such as the acoustic Japanese Koto or xylophone become evident:

(a) No tape recorder is required to record playing music to find out how accurately the musical instrument player is practicing. All music notes played by them are printed as the staff sheets thereby finding errors can be checked visually very easily.

(b) Practicing with this newly invented staff sheet printer is the same as having a music teacher giving lessens to the musical instrument players at any time.

(c) It can improve performance of the musical instrument players;

(d) The musical instrument players can save lesson fee and time using this staff sheet printer since repetitive lesson fees are not required; and

(e) The musical instrument players can make duplicate copy of own music notes easily.

In reality, the staff sheet printer 100 can connect with any musical instruments by changing the physical characteristics and shapes of

the sensors 130-1 and 130-2 (FIG. 2). For example, vibration sensors can be used for acoustic string instruments. These sensors converts string vibration, created by players who hit strings, to analog signal, and then it is converted to digital data by the signal-processing module 134. For acoustic wind instruments such as flute, mechanical sensors can be attached at underneath of each pad in each musical instrument. These sensors work ON or OFF mode, which are the same as binary number system used in computer system. Hence, it is so easy to translate finger motion to digital signal.

Operation – FIGS. 1, 2, 3, 4, 5, 6, and 7

To record the playing of Japanese Koto 10 and xylophone 20 using the newly invented staff sheet printer 100 (FIG. 1) is that a musical instrument player first needs to select a correct musical instrument for each sensor. In order to do that, the player first selects a type of the musical instrument by pressing up or down button 109 and 110, and left or right cursor control button 112 and 114 after R record button 106 pressed. The music player also needs to input the time signature 127-1 information parameter for the given note 121-1 and its tempo 123-1. For example, the portion of the music piece in FIG. 6 has the quarter note 121-1 with the speed 100 of the tempo 123-1 and the time signature of three quarter 127-1. First, the user selects the quarter note 121-1 by pressing up or down button 109 and 110 respectively. Pressing S/E button 102 confirms that the proper note is selected. The user selects the speed 100 of the tempo 123-1 next by moving the cursor to right by pressing the right arrow button 114 and pressing up or down arrow button 109 and 110 respectively. Then finally, the user needs to select the time signature of 127-1 using the same buttons as before. The player is simply asked to press a S/E button 102 before he/she begins.

Once the musical instrument player finishes playing the music, the player pushes the STP stop button 104 at any time. At this moment, the music played is converted and stored in a memory module 138 as a digital format. When the musical instrument player pushes a P print button 108, the staff sheet printer 100 prints music

staff sheets 60 with played music notes which it should be identical to original music sheets if there is no mistakes. However, if there are mistakes, the player can find out visually where the player hit wrong notes easily by comparing the printed staff sheets 60 with the original music sheets.

Conclusion, Ramifications, and Scope

Accordingly, the reader will see that the staff sheet printer for practicing musical instruments can be used as a virtual music teacher. Having this staff sheet printer will save lesson fee that is normally paid to music teachers. For novice musical instrument player, they can compose their music easily by using this staff sheet printer on any musical instruments since all notes played by them is printed as the music staff sheets. Furthermore, the staff sheet printer has the additional advantages in that

- a musical instrument player's performance can be improved well using this staff sheet printer;
- the musical instrument player can save lesson fee and time using this staff sheet printer since repetitive lesson fees are not required; and
- the printed music staff sheets can be duplicated since they are printed as the hard copy.

Although the description above contains many specifications, these should not be construed as limiting the scope of the invention but as merely providing illustrations of some of the presently preferred embodiments of this invention. For example, the staff sheet printer can connect to other musical instrument types by modifying the sensor.

Thus, the scope of the invention should not be determined by the appended claims and their legal equivalent, rather than by the example given.